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ABSTRACT

A technical, user and cost comparison study was undertaken to provide the Educational Resources Information Clearinghouse (ERIC) staff with data on silver halide, diazo, and vesicular type films for microfiche duplication. This information will allow ERIC to determine if diazo and/or vesicular films should be considered in producing ERIC duplicate microfiche. Technical considerations reviewed included film properties, such as resolution, density, contrast and definition, and production costs. User environment and archival film properties such as durability and permanence were studied and statistically valid user evaluation and technical tests run. In addition, relevant literature was reviewed and interviews with recognized authorities conducted. The conclusion was reached that both diazo and vesicular films should be considered for use in generating ERIC microfiche. There existed no serious reservations about image quality and user preference, and both types are attractive on a cost effective basis since a savings of approximately 27% results from their use. (Author/PB)

FINAL REPORT TO RESEARCH AND DEVELOPMENT RESOURCES, DISSEMINATION GROUP NATIONAL INSTITUTE OF EDUCATION, WASHINGTON, DC

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The author is indebted to the assistance of the participants in the user study and the cooperation of the commercial film and equipment producers who provided technical and cost data.

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ABSTRACT

After a careful review of existing information, personal interviews with recognized authorities and conducting two statistically valid user evaluation experiments, it is the author's opinion that both diazo and vesicular film should be considered for use to generate ERIC distribution microfiche.

The informed user community has no serious reservations about image quality and the individual reading for comprehension has no preference.

With a cost saving of approximately twenty-seven percent, both diazo and vesicular film are attractive on a cost effective basis.

I. INTRODUCTION

Traditionally the micropublishing library fields have used silver halide film for distribution of information on microfilm. Silver halide film is capable of faithfully reproducing fine details and has contrast characteristics which fit the users viewing and duplicating needs.

Within recent years, however, the microfilm state-of-the-art has advanced to the point where silver halide film is being seriously challenged by diazo and vesicular type film, in both technical performance and cost.

To take advantage of the advancing microfilm technology, increasing numbers of microfilm duplicate distributors are examining the cost savings possible by utilizing alternative microfilm film bases.

II. BACKGROUND

The Educational Resources Information Center (ERIC) is a national educational informational system operating under the National Institute of Education. Its purpose is to provide a means by which educators at all levels may more effectively utilize the knowledge produced by educational researchers, practioners and materials developers.

Most ERIC reports announced in the monthly publication, Research in Education, are available on the new COSATI standard 105 mm X 148 mm, 24X reduction silver halide microfiche or paper copy form.

The total ERIC document back file, from its inception in 1966 now totals over 68,000 titles (1.3 microfiche per title) and is growing at the rate of about 1,000 new titles every month. Standing orders for single ERIC microfiche cost $0.111, while on demand orders cost $.65 per title.

Should a library or information center wish to subscribe to the entire back file, the cost would be approximately $10,000.00.

With over 500 standing order subscribers and normal on demand sales, over one million microfiche are currently being produced every month.

III. STUDY OBJECTIVE

The objective of this study is to present to the ERIC staff, technical, cost and user acceptance data comparing silver halide, diazo and vesicular type films. This information will allow ERIC to determine if diazo and/or vesicular film should be considered in producing ERIC duplicate microfiche.

IV. TECHNICAL CONSIDERATION

Microfiche duplicates in large quantities are currently being produced on one of the three popular film bases; silver halide, diazo and vesicular. Although similar, each film has certain characteristics different from the other two.

A. FILM PROPERTIES

When considering a microform film material, certain important film image properties must be identified. Each of the following image properties, both singularly and in combination, contribute to legibility, or the ease of which a human user is able to read a written page on a microfilm reader screen.

1. Resolution

The ability of microfilm to record detail; a measure of the optical system to separate two closely spaced points, expressed as the number of lines per millimeter discernable in a standard National Bureau of Standards resolution test chart. If the resolution is high, it can be expected that lines and small print will be clear, rather than partially filled in as with low resolution. Usually, primary emphasis to legibility of microform images focuses on resolution only, rather than in reality, a combination of factors such as contrast and density.

2. Density

The light absorbing quality of a photographic image, visually expressed as a logarithim of the opacity.

3. Contrast

An expression of the relationship (difference) between the high and low density of a photographic image. If contrast is at a maximum then usually is this aspect of legibility.

4. Definition

The sharpness of the line edges forming the images. In the case of silver halide film with a suspended granular structure this factor is very important, while in the case of diazo film, the structure of the image is such that definition is usually good. Generally, all modern duplicating microfilms have been designed to produce excellent definition.

All three films examined for this report possess the film properties necessary to meet or exceed the COSATI microfiche standard as well as other existing microfiche standards.

B. FILM TYPES

1. Silver Halide

This film commonly is made up of an acetate base and a light sensitive layer of silver halides suspended in gelatin called the emulsion.

During the film developing process, the sub-microscopic particles of silver that have been light struck are reduced to black particles of silver by the action of the developer. A fixer solution and water washing yields the final image. This film must be processed in darkroom conditions due to the light sensitive nature of the film.

2. Diazo

Diazonium salts, mixed with chemical couplers and acid stabilizers form the base of diazo film. This film is processed in ambient light conditions using ultraviolet light, heat and gaseous ammonia.

Since this film utilizes a transparent dye system, the image is somewhat imbedded in the film base rather than laying on top as with the silver halide emulsion. This property produces an image that is slightly more scratch resistant than either silver halide or vesicular film.

This advantage of the diazo dye image being imbedded in the acetate film base may be short lived.

Since acetate has a tendancy to shrink, an increasing percentage of diazo films are now being produced on tri-acetate and polyester film bases. This change results in the diazo emulsion laying on top of the base similar to silver halide or vesicular film.

Because of the dye composition, diazo film is affected by high energy light. This causes the normally dark blue or black dye to change color to a lighter blue-purple color, resulting in a screen image of lower density and contrast.

A paper presented by Dr. G. W. W. Stevens of Eastman Kodak Research Laboratories demonstrates that diazo film, properly exposed and processed will produce copy that may give the appearance of higher resolution visually through a microscope than the original copy.

3. Vesicular

A heat processed film using ultraviolet light for exposing an image. Bubbles or "vesicules" are formed by the action of UV light or diazonium compounds in a plastic emulsion.

With a simple subjective examination of vesicular and other film images of equal resolution on a reader screen, the vesicular image seems sharper because of the overlapping three dimensional structure of the image, thereby reducing the subjective graininess.

Recently a stored vesicular film (Kalvar Type 10) was found to be discharging a gas (outgasing) that was corroding metal and cardboard containers. This film type has reportedly since been withdrawn and replaced with an improved type demonstrating stable characteristics.

Aside from this one type of Kalvar vesicular microfiche film with out gasing characteristics, other types of vesicular 35 mm roll film have been in storage for over fifteen years without outgasing problems.

It would be advisable to require a vesicular film producing company to submit additional data on the technical specifications of their film types to insure the outgasing problem has been eliminated.

Some authorities claim that as the vesicular process produces a physical image rather than a chemical image, and as this image is inert and thermodynamically stable, it can be considered excellent for long term storage of microform information. Unfortunately, this property cannot be scientifically documented bec the short span of time vesicular film has been in existance.

The following Table 1 compares the film characteristics of silver halide, diazo, and vesicular films for those criteria important to this study.

TABLE 1

Film Characteristics

	Silver Halide	Diazo	Vesicular
Reproduction Costs per Microfiche*	$0.0436	$0.0319	$0.0323
Resolution (Potential)	Over 500 1/mm	Over 800 1/mm	Over 500 1/mm
Scratch Resistance	Fair	Good to Excellent	Good
Image Life	Excellent	Excellent (estimated)	Excellent (estimated)
Image Contrast	Excellent	Excellent	Excellent
Viewing Equipment Compatibility	Compatible	Compatible	Compatible
Hard Copy Compatibility	Compatible	Compatible	Compatible
Microfiche Duplication	No Problem	No Problem	No Problem
Handling	Dark Room	Ambient Light	Ambient Light
Processing	2 Step Wet Process	Dry Process	Dry Process
Duplication Polarity	Reversing or non-reversing	Non-Reversing	Reversing

* Based on Tables 2, 3, 4.

C. PRODUCTION COST

In an attempt to determine an approximate cost per microfiche, based on production of 12 million microfiche per year, film manufacturers were contacted and requested to submit costs for film, equipment and labor. These costs were then reviewed by large volume micropublishers for "real life" accuracy.

Tables 2, 3, and 4 list the duplication production costs per microfiche as:

Silver Halide	- \$0.0436
Diazo	- \$0.0319 (27% saving)
Vesicular	- \$0.0323 (27% saving)

(The figures are based on an even production run with a variance of ± 10%).

The information shown in the tables are only for producing duplicates and cutting microfiche from a ready master roll. This does not include filming of masters, developing master roll, remaking of unacceptable duplicates, quality control or packaging in a form for shipment. Including the additional steps in the total microfiche production line, from master filming through shipping of complete sets, 0.050 ¢ to 0.080¢ per microfiche would be added.

TABLE 2

Silver Halide Microfiche Production Costs

Film	12,000 rolls/year @$37.50	$450,000.00
Chemicals		10,000.00
	TOTAL	$460,000.00
EQUIPMENT		
Duplicator	2 @$10,000.00	$ 20,000.00
Processor	2 @$12,000.00	24,000.00
Cutter	3 @$ 5,000.00	15,000.00
Loop Maker		1,250.00
Chemical Tanks, etc.		2,500.00
	TOTAL	$ 62,750.00
	Amortized over 5 years	$ 12,550.00
LABOR		
Supervisor	1 @$12,000.00/year	$ 12,000.00
Printer	1 @$ 9,000.00/year	8,000.00
Technician	2 @$ 7,000.00/year	14,000.00
	50% overhead	17,000.00
	TOTAL	$ 51,000.00
Total Film + Equipment + Labor		$523,550.00
Duplication Production Cost for Each Microfiche		$ 0.0436

TABLE 3

Diazo Microfiche Production Cost

Film	12,000 rolls/year @$26.91	$322,920.00
Chemicals		3,000.00
	TOTAL	$325,920.00
EQUIPMENT		
Duplicator/Processor	2 @$23,500.00	$ 47,000.00
Cutter	3 @$ 5,000.00	15,000.00
Loop Maker	1 @$ 1,250.00	1,250.00
	TOTAL	$ 63,250.00
	Amortized over 5 years	$ 12, 650.00
LABOR		
Supervisor	1 @$12,000.00/year	$ 12,000.00
Technician	2 @$ 9,000.00/year	18,000.00
	50% overhead /year	15,000.00
	TOTAL	$ 45,000.00
Total Film + Equipment + Labor		$383,570.00
Duplication Production Cost for each Microfiche		$ 0.0319

TABLE 4

Vesicular Microfiche Production Cost

Film	12,000 rolls/year @$27.75	$333,000.00
*EQUIPMENT		
Duplicator	2 @$16,000.00	$ 32,000.00
Cutter	3 @$ 5,000.00	15,000.00
Loop Maker	1 @$ 1,250.00	1,250.00
	TOTAL	$ 48,250.00
	Amortized over 5 years	$ 9,650.00
*LABOR		
Supervisor	1 @$12,000.00/year	$ 12,000.00
Technician	2 @$ 9,000.00/year	18,000.00
	50% overhead	15,000.00
	TOTAL	$ 45,000.00
Total Film + Equipment + Labor		$387,650.00
Duplication Production Cost for each Microfiche		$ 0.0323

(*Depending on the production facility, it may be possible to use only 1 duplicator/processor and 1 technician. This would result in a production cost of $ 0.0307 per microfiche).

V. LARGE GOVERNMENT MICROFICHE PRODUCERS

Case Studies

A. N.A.S.A.: Scientific and Technical Information Division

Since 1963, N.A.S.A. has distributed over 45 million microfiche produced on diazo film. On a regular basis, diazo microfiche of back files are pulled and examined for fade and deterioration of the image. To date, the diazo images are still perfectly legible and produce excellent duplicate microfiche or hard copy prints.

Using 7 mil acetate diazo film, some complaints still occur on film curl. This has resulted in a change to 7 mil polyester diazo film.

B. U. S. Department of Commerce; National Technical Information Service

In operation since 1964, NTIS has distributed over 30 million diazo microfiche. By July, 1973, they will be exclusively producing diazo microfiche. To date, there has been no evidence of image fading or deterioration.

C. Defense Documentation Center

Since 1965, DDC has distributed over 6 million microfiche; 80% diazo, 20% silver. As of February, 1973, only diazo duplicates are being produced.

Their back files, however, contain diazo microfiche produced since 1952. To date, there has been no evidence of image fading or deterioration.

D. Social Security Administration

From the start in 1959, the SSA has used 16 mm vesicular film for storage and use of their information. Since 1969, each of 1,000 field offices receive vesicular microfiche for referencing beneficiaries data. To date, no image fading or deterioration has been evident.

VI. ERIC USER ENVIRONMENT AND ARCHIVAL FILM PROPERTIES

Before any microfilm archival consideration can effectively be considered we must first define and examine the anticipated conditions for microfilm usage.

Of the approximately one million microfiche distributed each month by ERIC, 90% are located and used in traditional libraries or a reference room environment.

The film type selected for generation of distribution microfiche copies must be durable to withstand repeated usage in a wide variety of reader and reader printer types, as well as maintain a readable image (archival permanence) while housed in storage cabinets over an extended period of time.

A. Durability

All three films tested exhibit similar scratch resistance characteristics with the exception of diazo acetate film, that is slightly more scratch resistant than either silver halide or vesicular film.

B. Archival Permanence

The term "Archival Permanence" as referred to microforms by the American National Standards Institute (ANSI) Standard PH5.4 is only intended for silver halide film. The inability of diazo and vesicular film to meet the ANSI archival standard is not necessarily because of technical limitations but because insufficient time has elapsed on which to judge their archival permanance in the absence of suitable aging tests.

A confusion of definitions exists in the librarian's mind with relation to equating archival permanence of microforms to 100% rag stock paper, and its characteristic to remain unchanged over long periods of time.

Silver halide film has long claimed the characteristic of archival permanence. This is true only in a non-use situation.

An accurate definition of the archival permanence of silver halide film is limited to the following conditions:

> Upon exposure and correct processing the silver halide film must be placed in a sealed container and stored in a proper temperature-humidity environment.

It is only if the above directions are followed that the manufacturer can guarantee archival permanence. Once silver halide microfiche are used, their archival permanence property is void.

An American National Standards Institute Task Group was formed in 1971 to prepare film specifications, including archival permanence, for diazo and vesicular film. This task should be completed sometime in 1974.

These are examples of excellent keeping in many applications (see large scale users section) but there is a definite lack of quantatative scientific data on which film specifications can be based.

VII. USER EVALUATION

The objective of a user evaluation study was to determine the subjective reaction of users in reading from both a microfiche reader screen and hard copy made from the microfiche.

A. SAMPLE MICROFICHE

The sample microfiche distributed for evaluation were standard ERIC, COSATI format, 24X reduction, negative polarity, fourth generation microfiche.

Normally, ERIC users receive third generation distribution microfiche. In attempting to simulate a still worse condition fourth generation microfiche were made and distributed for evaluation.

B. USER POPULATION

Two titles (ED065-273, ED065-219) were randomly chosen from a recent issue of Research In Education, microfiche copies made in each of the three film bases, and fourth generation duplicates distributed.

1. Group I

Both titles, in each of the three film bases were sent to the following eight user locations involved in ERIC microfiche dissemination, production and use.

Educational Information Centers

- RISE; King of Prussia, Pennsylvania
- San Mateo County Educational Resources Center; California
- North Colorado Educational Board of Cooperative Sources; Boulder, Colorado

- SUNY; Albany, New York

ERIC Clearing Houses

- Ohio State University, Columbus, Ohio
- Modern Language Association; New York City, New York

Commercial Production Plant

- Bell & Howell; Wooster, Ohio

University

- University of Denver; Denver, Colorado

Microform Evaluation Center

- National Reprographic Center for Documentation; Hatfield, England

a. Evaluation Method

A "Microfiche Evaluation Form" (see Appendix I) requested each location to perform certain tasks, then examine and rate the resulting microfiche and hard copy prints. The evaluation criteria were:

i. Film image quality from each microfiche.

ii. Hard copy quality produced from each microfiche.

In addition, each location was requested to make a microfiche duplicate of the original microfiche, then examine and rate image quality as well as hard copy quality made from the microfiche duplicate. The microfiche duplicates produced at each user location were fifth generation microfiche.

Eight subjects evaluated the quality of two sets of microfiche filmed on three different film bases. (A-Silver Halide; B-Diazo; C-Vesicular). The film bases were rated by having the subject rank order the bases on four dimensions:

(1) Film Image Quality; (2) Hard Copy Quality; (3) Microfiche Duplicate Quality; and (4) Microfiche Duplicate-Hard Copy Quality (see Evaluation Form, Appendix I).

b. Results

Mean rankings of the three film bases for the two different microfiche sets are presented in Tables 5 and 6. Differences between rankings were analyzed using Friedman's two way analysis of variance (Siegel, S., Nonparametric Statistics, New York: McGraw-Hill, 1956, pps. 166-173), and the Chi Square values and their significance levels are presented in Tables 5 and 6.

The results for the two sets of microfiche were quite similar. There were no significant differences in rankings of Film Image Quality between the three bases for either microfiche. In terms of Hard Copy Quality, film base B was inferior to bases A and C for both microfiche. Each film base was ranked for Microfiche Duplicate Quality and Microfiche Duplicate-Hard Copy Quality, and the rankings were significantly different ($p < .05$) in every case except for the Duplicate-Hard Copy Quality rankings of the first microfiche where the differences were of marginal significance ($p = .052$). (The subject's raw scores appear in Appendix II).

c. Conclusion

Task I; Film Image Quality.

All three film bases are of equal image quality

Task II; Hard Copy Quality (see Appendix III).

Both silver halide and vesicular hard copy prints are of equal quality with the diazo print of lower quality.

TABLE 5

Mean Rankings of Three Film Bases on Four Dimensicns
(ERIC Microf:che ED 065-273)

Dimension Image Quality	Film Base A Silver Halide	B Diazo	C Vesicular	X_r^2 (Chi Square)
Film Image Quality I	2.2	2.1	1.8	.8
Hard Copy Quality II	1.6	2.9	1.5	9.3**
Film Image Dup. Qual. III	1.3	1.8	2.9	10.4**
Hard Copy Dup. Qual. IV	1.3	2.2	2.5	6.1

TABLE 6

Mean Rankings of Three Film Bases on Four Dimensions
(ERIC Microfiche ED 065-273)

Dimension Image Quality	Film Base A Silver Halide	B Diazo	C Vesicular	X_r^2 (Chi Square)
Film Image Quality I	1.9	2.4	1.8	1.8
Hard Copy Quality II	2.0	2.8	1.3	9.0**
Film Image Dup. Qual. III	1.4	1.9	2.8	7.8*
Hard Copy Dup. Qual. IV	1.4	1.9	2.8	7.8*

*rankings significantly different at $p < .05$

**rankings significantly different at $p < .01$

The silver halide microfiche image quality was superior to the diazo, which in turn was superior to the vesicular.

Although the Task III results are significant for the study in comparing one film against the other two, even the poorest quality image was perfectly readable. It is only of lower quality within this study. In addition the probability of any ERIC user ever receiving a fifth generation microfiche are slight.

Task IV; Hard Copy Duplicate Quality (see Appendix IV)

The same comments as Task III above apply.

2. Group II

a. Evaluation Method

One frame of both titles, in each of the three film bases was shown to a total of 60 persons. One group of 30 was shown one title (fourth generation) while the second group of 30 was shown the second title (fifth generation).

If a subject agreed to participate (no subjects refused), he was shown instructions (Appendix V) and asked to rate the

APPENDIX IV

HARD COPY SAMPLE FROM FIFTH GENERATION MICROFICHE (SILVER HALIDE)

Weise, Ingrid Bergstrom. Guidelines for a Supervisory Program Directed to Relating the Mathematics Programs of the Elementary and Junior High School. (U. Maryland, 1966.) Dis. Abst. 27A: 3686; May 1967. (a-6; b-3, t-2b)

A2

Walker, Latney Conrad, Jr. A Study of Interrelationships in Arithmetical Problem Solving. (U. Southern Mississippi, 1962.) Dis. Abst. 23: 3750-3751; Apr. 1963. (a-5b)

Wells, David Wayne. The Relative Effectiveness of Teaching First Year Algebra by Television-Correspondence Study and Teaching First Year Algebra by Conventional Methods. (U. Nebraska Teachers College, 1959.) Dis. Abst. 20: 3137; Feb. 1960. (a-4; c-22, d-4)

Werner, Sister Marijane. An Application of Critical Path Analysis to the Design of a Systematically Articulated Curriculum in Science and Mathematics for Secondary Schools. (Boston College, 1968.) Dis. Abst. 29A: 4209-4210; June 1969. (b-4; a-51, b-3)

West, Anita S. Wolfe. Development of a Computer-Administered Diagnostic College Placement Test in Mathematics. (U. Denver, 1969.) Dis. Abst. 30B: 5154-5155; May 1970. (f-1a; d-6b, e-1b, p-2)

Wetter, Donald Merlin. An Analysis of the Preparation of Secondary School Teachers of Mathematics with Special Reference to the New Mathematics Programs. (U. Nebraska Teachers College, 1966.) Dis. Abst. 27A: 1289; Nov. 1966. (t-2b)

Whelan, James Francis. Correlation of the Professional and Subject

three different images on their legibility using a 4-point scale with 1 as excellent, 2 as good, 3 as acceptable, and 4 as poor.

The 2X3 design included either a fourth or fifth generation microfiche image as between subjects factor and three types of film bases as a within subjects factor. (The subject's raw scores appear in Appendix VI).

b. Results

Table 7 presents the mean legibility ratings. Clearly, there were no differences between the three different film bases. Fourth generation microfiches were rated as more readable than fifth generation microfiches. Fourth generation microfiches received an average rating of "good" ($\bar{X}$=2.1) while fifth generation microfiches were rated as having "acceptable" readability ($\bar{X}$=3.4). A repeated measures analysis of variance (Winer, B.J., Statistical Principles in Experimental Design, New York: McGraw-Hill, 1971, pps. 518-534) supported this interpretation with no significant differences due to Film Base ($F < 1.0$, df 2/116) and significant differences ($F=253.5$, df=1/58, $p < .001$) between fourth and fifth generation microfiches. There were no interactions. (Table 8 presents a summary of Analysis of Variance).

c. Conclusions

When combining both groups of 30 subjects, there are no differences between the readibility of each of the 3 types of film.

As expected, the fifth generation image was rated less readable than the fourth generation image but still perfectly acceptable.

TABLE 7

Mean Legibility Ratings for Film Base Type and Generation

Generation	Film Base A	Film Base B	Film Base C
4th	2.1	2.1	2.0
5th	3.4	3.3	3.4

TABLE 8

Summary of Analysis of Variance

Source of Variation	df	MS	F
Between			
Generation (A)	1	76.05	253.5**
Subjects within groups	58	.30	
Within			
Film Base (B)	2	.02	1
A X B	2	.07	1
B X subjects within groups	116	.30	

$^{**}p < .001$

C. Technical Film Tests

To determine the film image fading characteristics for each film, light exposure tests were conducted.

A microfiche of each of the three film bases was placed in a Realist Vantage I microfiche reader, with a 150 watt FDV lamp, (150 watts, 3,400 lumens, 3250° Kelvin; temperature at film plane 140°F), and one frame exposed for a total of 18 hours (eight hours per day - three days). The results are described below with the microfiche used located in Appendix X.

1. Silver Halide - No apparent image quality was evident.

2. Diazo - After approximately one hour, a color change was apparent in the background. Within the next hour, the background color changed from the normal dark blue-black to a light to medium purple. After the second hour, the color stabilized and no further change was apparent for the remainder of the exposure test. Although the image was legible, both on the microfiche reader screen as well as in hard copy form, the reduced background density caused loss of image contrast and resulted in a less readable image (see Appendix X).

3. Vesicular - After approximately four hours exposure a slight color change was noticable when the microfiche was examined visually. There was no apparent change, however, in background density on the microfiche reader screen (see Appendix X).

VIII. CONCLUSION AND RECOMMENDATIONS

After careful review of the technical, cost and user evaluation criteria, it is evident that both diazo and vesicular, in addition to silver halide film, should be considered for generating ERIC distribution microfiche provided certain film characteristics are recognized.

A. TECHNICAL CONSIDERATIONS

Although no film specifications for archival permanence exist, for diazo and vesicular film, large volume micropublishers report no evidence of image fading or deterioration for either diazo or vesicular film that would produce an unreadable image over an extended period of storage.

Diazo film, when exposed to a 150 watt lamp in a standard microfiche reader exhibited a color change that reduced the density-contrast of the image (see Appendix X). It should be generally expected with the rapidly advancing microfilm state-of-the-art that both films will further improve and with upcoming laboratory accelerated archival testing an archival permanence standard will soon be recognized for both diazo and vesicular film.

The three films examined have or exceed the minimum existing specifications required for COSATI microfiche standards.

B. COST CONSIDERATIONS

By using diazo or vesicular duplicating film, a cost saving of approximately 27 percent can be achieved from the existing cost of silver halide ERIC distribution microfiche.

C. USER CONSIDERATIONS

Two experimentally valid studies compared users subjective evaluations to the image legibility of microfiche as well as hard copy. There were no significant legibility differences between the three types of film bases as reported by users.

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18. Salmon, Stephen R. Specifications for Library of Congress Microfilming. Washington, D. C.: Government Printing Office, 1964, 21 pp.

19. Spreitzer, Francis F. "Developments in Copying, Micrographics, and Graphic Communications, 1971." Library Resources & Technical Services, 16 (Spring, 1972), 135-154.

20. Veaner, Allen B. The Evaluation of Micropublications: A Handbook For Librarians. Chicago: American Library Association (LTP Publication No. 17), 1971, 59 pp.

21. ________________. "Microreproduction and Micropublication Technical Standards -- What They Mean to You, the User." Choice, 5 (September, 1968), 739-44.

22. Williams, Bernard J. S. Miniaturised Communications: A Review of Microforms. London: The Library Association, 1970, 190 pp.

23. ________________. Thesaurus of Micrographic Terms. 2nd ed. Hatfield, England: The National Reprographic Centre for Documentation, 1972, 42 pp.

APPENDICIES

APPENDIX I

Organization Name ____________________

Address ____________________

ERIC MICROFICHE EVALUATION FORM

Rank each of the three microfiche (a,b,c) using a scale from 1 to 3 with 1 being the highest quality and 3 the lowest. Use zero (0) in place of the numbers 1 to 3 if No discernable differences are apparent between the images on each microfiche.

TASK I:	FILM IMAGE QUALITY	Microfiche	Score
	Place each of the 3 microfiche in a reader and examine the screen image for ease of reading.	A	
		B	
		C	
TASK II:	HARD COPY QUALITY	Hard copy	Score
	Make a hard copy of one (1) page from each of the 3 microfiche and compare the readability of each.	A	
		B	
		C	
TASK III:	MICROFICHE DUPLICATE QUALITY	Microfiche	Score
	Make a microfiche duplicate from each of the 3 microfiche, place in a reader and examine the screen image as in TASK I.	A	
		B	
	*(type of duplicate created? diazo, vesicular; please circle one)	C	
TASK IV:	MICROFICHE DUPLICATE - HARD COPY QUALITY	Hard copy	Score
	From the microfiche duplicates generated in TASK III make a hard copy of one (1) and compare as in TASK II.	A	
		B	
		C	

*PLEASE MAKE ANY ADDITIONAL COMMENTS ON THE REVERSE SIDE

APPENDIX II

Group I: Microfiche/Hard Copy Evaluation Raw Scores
ERIC Microfiche ED 065-219

	Evaluators								
	1	2	3	4	5	6	7	8	
Task I: Film Image Quality									
Microfiche A	2	1	2	3	2	2	2	1	15
Microfiche B	1	3	3	1	3	3	3	2	19
Microfiche C	3	2	1	2	1	1	1	3	14
Task II: Hard Copy Quality									
Microfiche A	0	1	2	2	2	2	2	3	14
Microfiche B	0	3	3	3	3	3	3	2	20
Microfiche C	0	2	1	1	1	1	1	1	8
Task III: Microfiche Duplicate Quality									
Microfiche A	2	1	1	3	1	1	1	1	12
Microfiche B	1	2	2	1	2	2	2	3	15
Microfiche C	3	3	3	2	3	3	3	2	22
Task IV: Microfiche Duplicate Hardcopy Quality									
Microfiche A	0	1	1	1	2	1	1	2	9
Microfiche B	0	2	2	3	1	2	2	1	13
Microfiche C	0	3	3	2	3	3	3	3	20

APPENDIX II

Group I: Microfiche/Hard Copy Evaluation Raw Scores
ERIC Microfiche ED 065-273

	Evaluators 1	2	3	4	5	6	7	8	
Task I: Film Image Quality									
Microfiche A	1	1	2	3	2	2	3	3	17
Microfiche B	1	3	3	1	3	3	1	1	16
Microfiche C	3	2	1	2	1	1	2	2	14
Task II: Hard Copy Quality									
Microfiche A	0	1	2	2	2	2	1	1	11
Microfiche B	0	3	3	3	3	3	3	3	21
Microfiche C	0	2	1	1	1	1	2	2	10
Task III: Microfiche Duplicate Quality									
Microfiche A	1	1	1	1	2	1	1	2	10
Microfiche B	1	3	2	2	1	2	2	1	14
Microfiche C	3	2	3	3	3	3	3	3	23
Task IV: Microfiche Duplicate Hard Copy Quality									
Microfiche A	1	1	1	2	2	1	1	1	10
Microfiche B	1	3	2	3	1	2	2	3	17
Microfiche C	3	2	3	1	3	3	3	2	20

APPENDIX III

HARD COPY SAMPLE FROM FOURTH GENERATION MICROFILM (SILVER HALIDE)

Weise, Ingrid Bergstrom. Guidelines for a Supervisory Program Directed to Relating the Mathematics Programs of the Elementary and Junior High School. (U. Maryland, 1966.) Dis. Abst. 27A: 3686; May 1967. (a-6; b-3, t-2b)

Welker, Latney Conrad, Jr. A Study of Interrelationships in Arithmetical Problem Solving. (U. Southern Mississippi, 1962.) Dis. Abst. 23: 3750-3751; Apr. 1963. (a-5b)

Wells, David Wayne. The Relative Effectiveness of Teaching First Year Algebra by Television-Correspondence Study and Teaching First Year Algebra by Conventional Methods. (U. Nebraska Teachers College, 1959.) Dis. Abst. 20: 3137; Feb. 1960. (a-4; c-22, d-4)

Werner, Sister Marijane. An Application of Critical Path Analysis to the Design of a Systematically Articulated Curriculum in Science and Mathematics for Secondary Schools. (Boston College, 1968.) Dis. Abst. 29A: 4209-4210; June 1969. (b-4; a-5i, b-3)

West, Anita S. Wolfe. Development of a Computer-Administered Diagnostic College Placement Test in Mathematics. (U. Denver, 1969.) Dis. Abst. 30B: 5154-5155; May 1970. (f-1a; d-6b, e-1b, p-2)

Wetter, Donald Merlin. An Analysis of the Preparation of Secondary School Teachers of Mathematics with Special Reference to the New Mathematics Programs. (U. Nebraska Teachers College, 1966.) Dis. Abst. 27A: 1289; Nov. 1966. (t-2b)

Whelan, James Francis. Correlation of the Professional and Subject Matter Training in the Preparation of Teachers of High School Mathematics. (Ohio State U., 1938.) (t-1b)

Whitaker, Mack L. A Study of Participants in Summer Mathematics Institutes Sponsored by the National Science Foundation. (Florida State U., 1961.) Dis. Abst. 22: 2712; Feb. 1962. (t-2b; d-9)

Whitcraft, Leslie H. Some of the Influences of the Requirements and Examinations of the College Entrance Examination Board on the Mathematics Requirements in the Secondary Schools of the U.S. (Teachers College, Columbia U., 1932.) (f-2c; b-3, p-1)

White, Annabel Lee. Retention of Elementary Algebra Through Quadratics After Varying Intervals of Time. (Johns Hopkins U., 1930.) (g-2; c-22)

Wiebe, Arthur John. The Comparative Effects of Three Methods of Utilizing Programmed Mathematics Materials with Low-Achievers. (Stanford U., 1966.) Dis. Abst. 27A: 1002-1003; Oct. 1966. (d-5; c-21, e-2a, g-6)

APPENDIX III

HARD COPY SAMPLE FROM FOURTH GENERATION MICROFILM (DIAZO)

Weise, Ingrid Bergstrom. Guidelines for a Supervisory Program Directed to Relating the Mathematics Programs of the Elementary and Junior High School. (U. Maryland, 1966.) Dis. Abst. 27A: 3686; May 1967. (a-6; b-3, t-2b)

P,

Welker, Latney Conrad, Jr. A Study of Interrelationships in Arithmetical Problem Solving. (U. Southern Mississippi, 1962.) Dis. Abst. 23: 3750-3751; Apr. 1963. (a-5b)

Wells, David Wayne. The Relative Effectiveness of Teaching First Year Algebra by Television-Correspondence Study and Teaching First Year Algebra by Conventional Methods. (U. Nebraska Teachers College, 1959.) Dis. Abst. 20: 3137; Feb. 1960. (a-4; c-22, d-4)

Werner, Sister Marijane. An Application of Critical Path Analysis to the Design of a Systematically Articulated Curriculum in Science and Mathematics for Secondary Schools. (Boston College, 1968.) Dis. Abst. 29A: 4209-4210; June 1969. (b-4; a-5i, b-3)

West, Anita S. Wolfe. Development of a Computer-Administered Diagnostic College Placement Test in Mathematics. (U. Denver, 1969.) Dis. Abst. 30B: 5154-5155; May 1970. (f-1a; d-6b, e-1b, p-2)

Wetter, Donald Merlin. An Analysis of the Preparation of Secondary School Teachers of Mathematics with Special Reference to the New Mathematics Programs. (U. Nebraska Teachers College, 1966.) Dis. Abst. 27A: 1289; Nov. 1966. (t-2b)

Whelan, James Francis. Correlation of the Professional and Subject Matter Training in the Preparation of Teach[illegible] of High School Mathematics. (Ohio State U., 1938.) (t-1b)

Whitaker, Mack L. A Study of Participants in Sum[illegible] Mathematics Institutes Sponsored by the National Science Foun[illegible]ion. (Florida State U., 1961.) Dis. Abst. 22: 2712; Feb. 1962. [illegible]-2b; d-9)

Whitcraft, Leslie H. Some of the Influences of the R[illegible]ments and Examinations of the College Entrance Examination [illegible] on the Mathematics Requirements in the Secondary Schools of th[illegible] S. (Teachers College, Columbia U., 1932.) (f-2c; b-3, p-1)

White, Annabel Lee. Retention of Elementary Algebra Through Quadratics After Varying Intervals of Time. (Johns Hopkins U., 1930.) (g-2; c-22)

Wiebe, Arthur John. The Comparative Effects of Three Methods of Utilizing Programmed Mathematics Materials with Low-Achievers. (Stanford U., 1966.) Dis. Abst. 27A: 1002-1003; Oct. 1966. (d-5; c-21, e-2a, g-6)

APPENDIX III

Hard Copy Sample from Fourth Generation Microfilm (Vesicular)

Weise, Ingrid Bergstrom. Guidelines for a Supervisory Program Directed to Relating the Mathematics Programs of the Elementary and Junior High School. (U. Maryland, 1966.) Dis. Abst. 27A: 3686; May 1967. (a-6; b-3, t-2b)

Welker, Latney Conrad, Jr. A Study of Interrelationships in Arithmetical Problem Solving. (U. Southern Mississippi, 1962.) Dis. Abst. 23: 3750-3751; Apr. 1963. (a-5b)

Wells, David Wayne. The Relative Effectiveness of Teaching First Year Algebra by Television-Correspondence Study and Teaching First Year Algebra by Conventional Methods. (U. Nebraska Teachers College, 1959.) Dis. Abst. 20: 3137; Feb. 1960. (a-4; c-22, d-4)

Werner, Sister Marijane. An Application of Critical Path Analysis to the Design of a Systematically Articulated Curriculum in Science and Mathematics for Secondary Schools. (Boston College, 1968.) Dis. Abst. 29A: 4209-4210; June 1969. (b-4; a-51, b-3)

West, Anita S. Wolfe. Development of a Computer-Administered Diagnostic College Placement Test in Mathematics. (U. Denver, 1969.) Dis. Abst. 30B: 5154-5155; May 1970. (f-1a; 1-6b, e-1b, p-2)

Wetter, Donald Merlin. An Analysis of the Preparation of Secondary School Teachers of Mathematics with Special Reference to the New Mathematics Programs. (U. Nebraska Teachers College, 1966.) Dis. Abst. 27A: 1289; Nov. 1966. (t-2b)

Whelan, James Francis. Correlation of the Professional and Subject Matter Training in the Preparation of Teachers of High School Mathematics. (Ohio State U., 1938.) (t-1b)

Whitaker, Mack L. A Study of Participants in Summer Mathematics Institutes Sponsored by the National Science Foundation. (Florida State U., 1961.) Dis. Abst. 22: 2712; Feb. 1962. (t-2b; d-9)

Whitcraft, Leslie H. Some of the Influences of the Requirements and Examinations of the College Entrance Examination Board on the Mathematics Requirements in the Secondary Schools of the U.S. (Teachers College, Columbia U., 1932.) (f-2c; b-3, p-1)

White, Annabel Lee. Retention of Elementary Algebra Through Quadratics After Varying Intervals of Time. (Johns Hopkins U., 1930.) (g-2; c-22)

Wiebe, Arthur John. The Comparative Effects of Three Methods of Utilizing Programmed Mathematics Materials with Low-Achievers. (Stanford U., 1966.) Dis. Abst. 27A: 1002-1003; Oct. 1966. (d-5; c-21, e-2a, g-6)

APPENDIX IV

HARD COPY SAMPLE FROM FIFTH GENERATION MICROFICHE (DIAZO)

B2

Weise, Ingrid Bergstrom. Guidelines for a Supervisory Program Directed to Relating the Mathematics Programs of the Elementary and Junior High School. (U. Maryland, 1966.) Dis. Abst. 27A: 3686; May 1967. (a-6; b-3, t-2b)

Welker, Latney Conrad, Jr. A Study of Interrelationships in Arithmetical Problem Solving. (U. Southern Mississippi, 1962) Dis. Abst. 23: 3750-3751; Apr. 1963. (a-5b)

Wells, David Wayne. The Relative Effectiveness of Teaching First Year Algebra by Television-Correspondence Study and Teaching First Year Algebra by Conventional Methods. (U. Nebraska Teachers College, 1959.) Dis. Abst. 20: 3137; Feb. 1960. (a-4; c-22, d-4)

Werner, Sister Marijane. An Application of Critical Path Analysis to the Design of a Systematically Articulated Curriculum in Science and Mathematics for Secondary Schools. (Boston College, 1968.) Dis. Abst. 29A: 4209-4210; June 1969. (b-4; a-5i, b-3)

West, Anita S. Wolfe. Development of a Computer-Administered Diagnostic College Placement Test in Mathematics. (U. Denver, 1969.) Dis. Abst. 30B: 5154-5155; May 1970. (f-1a; d-6b, e-1b, p-2)

Wetter, Donald Merlin. An Analysis of the Preparation of Secondary School Teachers of Mathematics with Special Reference to the New Mathematics Programs. (U. Nebraska Teachers College, 1966.) Dis. Abst. 27A: 1289; Nov. 1966. (t-2b)

Whelan, James Francis. Correlation of the Professional and Subject Matter Training in the Preparation of Teachers of High School Mathematics. (Ohio State U., 1938.) (t-1b)

Whitaker, Mack L. A Study of Participants in Summer Mathematics Institutes Sponsored by the National Science Foundation. (Florida State U., 1961.) Dis. Abst. 22: 2712; Feb. 1962. (t-2b; d-9)

Whitcraft, Leslie H. Some of the Influences of the Requirements and Examinations of the College Entrance Examination Board on the Mathematics Requirements in the Secondary Schools of the U.S. (Teachers College, Columbia U., 1932.) (f-2c; b-3, p-1)

White, Annabel Lee. Retention of Elementary Algebra Through Quadratics After Varying Intervals of Time. (Johns Hopkins U., 1930.) (g-2; c-22)

Wiebe, Arthur John. The Comparative Effects of Three Methods of Utilizing Programmed Mathematics Materials with Low-Achievers. (Stanford U., 1966.) Dis. Abst. 27A: 1002-1003; Oct. 1966. (d-5; c-21, e-2a, g-6)

APPENDIX IV

HARD COPY SAMPLE FROM FIFTH GENERATION MICROFICHE (VESICULAR)

C2.

Weise, Ingrid Bergstrom. Guidelines for a Supervisory Program Directed to Relating the Mathematics Programs of the Elementary and Junior High School. (U. Maryland, 1966.) Dis. Abst. 27A: 3686; May 1967. (a-6; b-3, t-2b)

Welker, Latney Conrad, Jr. A Study of Interrelationships in Arithmetical Problem Solving. (U. Southern Mississippi, 1962.) Dis. Abst. 23: 3750-3751; Apr. 1963. (a-5b)

Wells, David Wayne. The Relative Effectiveness of Teaching First Year Algebra by Television-Correspondence Study and Teaching First Year Algebra by Conventional Methods. (U. Nebraska Teachers College, 1959.) Dis. Abst. 20: 3137; Feb. 1960. (a-4; c-22, d-4)

Werner, Sister Marijane. An Application of Critical Path Analysis to the Design of a Systematically Articulated Curriculum in Science and Mathematics for Secondary Schools. (Boston College, 1968.) Dis. Abst. 29A: 4209-4210; June 1969. (b-4; a-5i, b-3)

West, Anita S. Wolfe. Development of a Computer-Administered Diagnostic College Placement Test in Mathematics. (U. Denver, 1969.) Dis. Abst. 30B: 5154-5155; May 1970. (f-1a; d-6b, e-1b, p-2)

Wetter, Donald Merlin. An Analysis of the Preparation of Secondary School Teachers of Mathematics with Special Reference to the New Mathematics Programs. (U. Nebraska Teachers College, 1966.) Dis. Abst. 27A: 1289; Nov. 1966. (t-2b)

Whelan, James Francis. Correlation of the Professional and Subject Matter Training in the Preparation of Teachers of High School Mathematics. (Ohio State U., 1938.) (t-1b)

Whitaker, Mack L. A Study of Participants in Summer Mathematics Institutes Sponsored by the National Science Foundation. (Florida State U., 1961.) Dis. Abst. 22: 2712; Feb. 1962. (t-2b; d-9)

Whitcraft, Leslie H. Some of the Influences of the Requirements and Examinations of the College Entrance Examination Board on the Mathematics Requirements in the Secondary Schools of the U.S. (Teachers College, Columbia U., 1932.) (f-2c; b-3, p-1)

White, Annabel Lee. Retention of Elementary Algebra Through Quadratics After Varying Intervals of Time. (Johns Hopkins U., 1930.) (g-2; c-22)

Wiebe, Arthur John. The Comparative Effects of Three Methods of Utilizing Programmed Mathematics Materials with Low-Achievers. (Stanford U., 1966.) Dis. Abst. 27A: 1002-1003; Oct. 1966. (d-5; c-21, e-2a, g-6)

APPENDIX V

Group II: Subject's Evaluation Instructions

Please look at the page image on the reader screen for each of three different pages.

Assign a number to each page from 1 to 4, depending on how easy to read you think each page is.

The scale is:

1 - Excellent

2 - Good

3 - Acceptable

4 - Poor

APPENDIX VI

Group II: Microfiche Image Evaluation
Raw Scores from Fifth Generation Microfiche

	Hard Copy					Hard Copy		
Subject	A_1	B_1	C_1		Subject	A_1	B_1	C_1
1	3	3	4		16	4	4	4
2	3	3	3		17	3	3	3
3	3	3	3		18	4	3	3
4	4	4	3		19	3	3	3
5	3	3	4		20	4	3	3
6	4	3	3		21	4	3	4
7	3	3	3		22	3	4	3
8	3	4	3		23	3	3	4
9	4	3	4		24	4	3	3
10	4	4	4		25	3	4	4
11	3	3	3		26	3	3	3
12	3	3	3		27	3	3	4
13	3	4	3		28	3	4	4
14	3	3	4		29	3	3	3
15	4	4	3		30	4	3	3

APPENDIX VI

Group II: Microfiche Image Evaluation
Raw Scores from Fourth Generation Microfiche

Subject	Hard Copy A_1	B_1	C_1
1	2	2	2
2	2	3	2
3	2	2	2
4	3	2	3
5	2	2	2
6	2	2	3
7	3	2	2
8	2	2	2
9	2	2	2
10	2	2	2
11	2	3	2
12	1	2	2
13	2	3	2
14	2	2	1
15	2	2	2

Subject	Hard Copy A_1	B_1	C_1
16	3	2	2
17	2	1	2
18	2	2	2
19	2	2	2
20	2	3	1
21	1	2	2
22	2	2	2
23	2	2	2
24	3	2	3
25	2	1	2
26	2	2	2
27	1	2	3
28	2	2	1
29	3	2	1
30	2	2	2

APPENDIX VII

Silver Halide Microfiche Distributed for Evaluation And Microfiche Duplicate Produced

ED 065 219 AGRICULTURAL MECHANIZATION AND THE MIGRANT IN NEW YORK STATE.
HOWARD W. TAYLOR. STATE UNIV. OF NEW YORK. GENESCO CENTER FOR MIGRANT STUDIES.; STATE UNIV. OF NEW YORK. GENESCO COLL. 72. 57P. .

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APPENDIX VIII

Diazo Microfiche Distributed for Evaluation And Microfiche Duplicate Produced

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APPENDIX IX

Vesicular Microfiche Distributed for Evaluation And Microfiche Duplicate Produced

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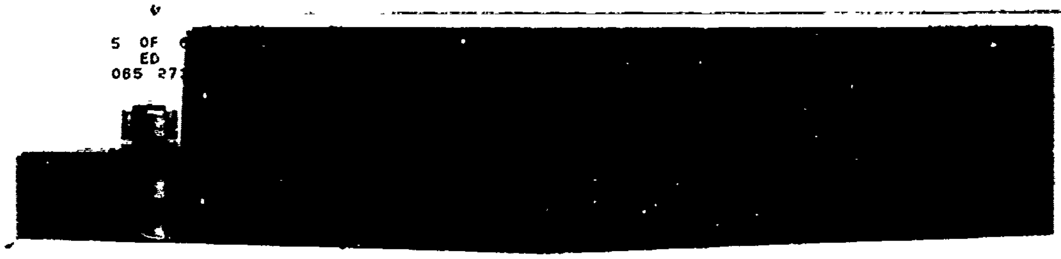
APPENDIX X

Microfiche Light Exposure Test



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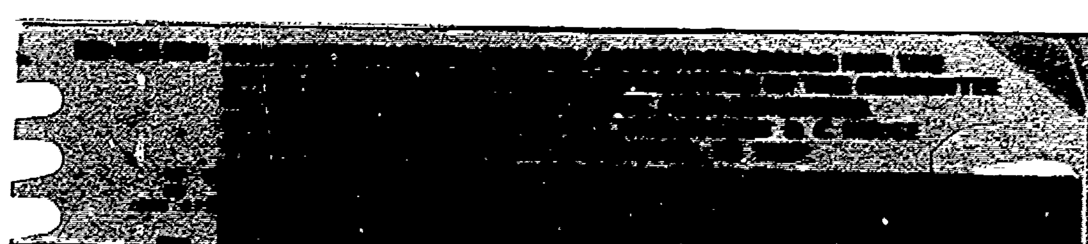

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